

### C.) AMENDMENTS TO THE CLAIMS

This listing of claims will replace all prior versions and listings of claims in the application:

1. (Currently Amended) A heat treatment process for restoring the properties of an aircraft engine article having a cast portion comprising a nickel-based superalloy having a nominal composition, in weight percent, of about 18.5 percent iron, about 18.5 percent chromium, about 5.1 percent niobium, about 3 percent molybdenum, about 0.9 percent titanium, about 0.5 percent aluminum, about 0.04 percent carbon, and balance nickel ~~of about 19 percent iron, about 18 percent chromium, about 5 percent terbium and niobium, about 3 percent molybdenum, about 0.9 percent titanium, about 0.5 percent aluminum, about 0.05 percent carbon, about 0.009 percent boron, a maximum of about 1 weight percent cobalt, a maximum of about 0.35 weight percent manganese, a maximum of about 0.35 weight percent silicon, a maximum of about 0.1 weight percent copper, balance nickel and impurities~~ and a forged portion that has been subjected to repeated thermal cycles below the  $\delta$  solvus comprising the steps of:

providing an article comprising a nickel-based superalloy having a nominal composition, in weight percent, of about 18.5 percent iron, about 18.5 percent chromium, about 5.1 percent niobium, about 3 percent molybdenum, about 0.9 percent titanium, about 0.5 percent aluminum, about 0.04 percent carbon, and balance nickel ~~of about 19 percent iron, about 18 percent chromium, about 5 percent terbium and niobium, about 3 percent molybdenum, about 0.9 percent titanium, about 0.5 percent aluminum, about 0.05 percent carbon, about 0.009 percent boron, a maximum of about 1 weight percent cobalt, a maximum of about 0.35 weight percent manganese, a maximum of about 0.35 weight percent silicon, a maximum of about 0.1 weight percent copper, balance nickel and impurities~~ to be treated;

heating the article in a non-oxidative atmosphere, at a rate to minimize distortion of the article, to a temperature in a range of about 975°F to about 1025°F and stabilizing the temperature of the article in this temperature range;

within 60 minutes of stabilizing the article in the temperature range of about

975°F to about 1025°F heating the article to a second temperature in the range of about 1950°F to about 2150°F;

holding the article at a temperature in the range of about 1950°F to about 2150°F for a time sufficient to fully solution precipitates;

cooling the article to a temperature in the range of about 1000°F to about 1200°F in a protective atmosphere at a rate sufficient to maintain dimensional stability while avoiding the formation of  $\delta$  phase;

cooling the article to room temperature; and  
removing the forged portion of the article.

2. (Original) The process as in claim 1, wherein the step of heating further includes a non-oxidative atmosphere is a vacuum having a pressure of about 0.5 micron.

3. (Cancelled)

4. (Currently Amended) The process as in claim 1, wherein the process includes welding the treated cast article comprising a nickel-based superalloy having a nominal composition, in weight percent, of about 18.5 percent iron, about 18.5 percent chromium, about 5.1 percent niobium, about 3 percent molybdenum, about 0.9 percent titanium, about 0.5 percent aluminum, about 0.04 percent carbon, and balance nickel ~~of about 19 percent iron, about 18 percent chromium, about 5 percent terbium and niobium, about 3 percent molybdenum, about 0.9 percent titanium, about 0.5 percent aluminum, about 0.05 percent carbon, about 0.009 percent boron, a maximum of about 1 weight percent cobalt, a maximum of about 0.35 weight percent manganese, a maximum of about 0.35 weight percent silicon, a maximum of about 0.1 weight percent copper, balance nickel and impurities~~ to new wrought portion article comprising a nickel-based superalloy having a nominal composition, in weight percent, of about 18.5 percent iron, about 18.5 percent chromium, about 5.1 percent niobium, about 3 percent molybdenum, about 0.9 percent titanium, about 0.5 percent aluminum, about 0.04 percent carbon, and balance nickel ~~of about 19 percent iron, about 18 percent chromium, about 5 percent terbium and niobium,~~

~~about 3 percent molybdenum, about 0.9 percent titanium, about 0.5 percent aluminum, about 0.05 percent carbon, about 0.009 percent boron, a maximum of about 1 weight percent cobalt, a maximum of about 0.35 weight percent manganese, a maximum of about 0.35 weight percent silicon, a maximum of about 0.1 weight percent copper, balance nickel and impurities after the cooling step, to yield a repaired article.~~

5. (Original) The process as in claim 4, wherein the process includes heat treating at a temperature in the range of about 1500°F to about 1600°F and holding for a first preselected period, followed by lowering the temperature to a temperature in the range of about 1350°F to about 1450°F and holding for a second preselected period, followed by lowering the temperature to a temperature in the range of about 1100°F to about 1200°F and holding for a third preselected period, so as to develop  $\gamma'$  and  $\gamma''$ , while also relieving welding stresses in the welded article after the step of welding the wrought article to the cast article.

6. (Original) The process as in claim 5, wherein the first preselected period is about one hour, the second preselected period is about eight hours, and the third preselected period is about four hours.

7. (Currently Amended) The process as in claim 1, wherein the process includes welding, after the cooling step, the treated cast article comprising a nickel-based superalloy having a nominal composition, in weight percent, of about 18.5 percent iron, about 18.5 percent chromium, about 5.1 percent niobium, about 3 percent molybdenum, about 0.9 percent titanium, about 0.5 percent aluminum, about 0.04 percent carbon, and balance nickel ~~of about 19 percent iron, about 18 percent chromium, about 5 percent terbium and niobium, about 3 percent molybdenum, about 0.9 percent titanium, about 0.5 percent aluminum, about 0.05 percent carbon, about 0.009 percent boron, a maximum of about 1 weight percent cobalt, a maximum of about 0.35 weight percent manganese, a maximum of about 0.35 weight percent silicon, a maximum of about 0.1 weight percent copper, balance nickel and impurities~~ to a wrought article, wherein the wrought article is an alloy selected

from the group consisting of a nickel-based superalloy having a nominal composition, in weight percent, of about 19 percent chromium, about 12.3 percent cobalt, about 3.8 percent molybdenum, about 3.0 percent titanium, about 1.2 percent aluminum, about 0.01 percent zirconium, about 0.45 percent manganese, about 0.06 percent carbon, about 0.005 percent boron, and balance nickel ~~of about 19 percent chromium, about 13.5 percent cobalt, about 4.3 percent molybdenum, about 3 percent titanium, about 1.5 percent aluminum, about 0.08 percent carbon, about 0.006 percent boron, a maximum of about 2 percent iron, a maximum of about 0.15 percent silicon, a maximum of about 0.1 percent manganese, a maximum of about 0.1 percent copper, about 0.05 percent zirconium, balance nickel and impurities and a nickel-based superalloy having a nominal composition, in weight percent, of about 19.0 percent chromium, about 10.5 percent cobalt, about 9.5 percent molybdenum, about 3.2 percent titanium, about 1.7 percent aluminum, about 0.01 percent zirconium, about 0.08 percent carbon, about 0.005 percent boron, and balance nickel~~ ~~of about 19 percent chromium, about 11 percent cobalt, about 10 percent molybdenum, about 3.1 percent titanium, about 1.5 percent aluminum, about 0.09 percent carbon, about 0.006 percent boron, a maximum of about 5 percent iron, a maximum of about 0.5 percent silicon, a maximum of about 0.1 percent manganese, balance nickel and impurities, to yield a repaired article.~~

8. (Original) The process as in claim 7, wherein the process includes heat treating at a temperature in the range of about 1500°F to about 1600°F and holding for a first preselected period, followed by lowering the temperature to a temperature in the range of about 1250°F to about 1350°F and holding for a second preselected period, followed by lowering the temperature to a temperature in the range of about 1150°F to about 1250°F and holding for a third preselected period, so as to develop  $\gamma'$  and  $\gamma''$ , while also relieving welding stresses in the welded article after the step of welding the wrought article to the cast article.

9. (Original) The process as in claim 8, wherein the first preselected period is about one hour, the second preselected period is about eight hours, and the third preselected

period is about one hour.

10. (Currently Amended) The process as in claim 1, wherein the process includes welding the treated cast article of about 18.5 percent iron, about 18.5 percent chromium, about 5.1 percent niobium, about 3 percent molybdenum, about 0.9 percent titanium, about 0.5 percent aluminum, about 0.04 percent carbon, and balance nickel ~~comprising a nickel-based superalloy having a nominal composition, in weight percent, of about 19 percent iron, about 18 percent chromium, about 5 percent terbium and niobium, about 3 percent molybdenum, about 0.9 percent titanium, about 0.5 percent aluminum, about 0.05 percent carbon, about 0.009 percent boron, a maximum of about 1 weight percent cobalt, a maximum of about 0.35 weight percent manganese, a maximum of about 0.35 weight percent silicon, a maximum of about 0.1 weight percent copper, balance nickel and impurities to a wrought article comprising a iron-based superalloy having a nominal composition, in weight percent, of about 38 percent nickel, 15 percent cobalt, 0.7 percent aluminum, 1.4 percent titanium, 3 percent niobium, and 41.0 percent iron of about 38 percent nickel, 15 percent cobalt, 0.9 percent aluminum, 1.4 percent titanium, 3 percent niobium, balance iron and impurities after the cooling step, to yield a repaired article.~~

11. (Original) The process as in claim 7, wherein the process includes heat treating at a temperature in the range of about 1500°F to about 1600°F and holding for a first preselected period, followed by lowering the temperature to a temperature in the range of about 1250°F to about 1350°F and holding for a second preselected period, followed by lowering the temperature to a temperature in the range of about 1100°F to about 1200°F and holding for a third preselected period, so as to develop  $\gamma'$  and  $\gamma''$ , while also relieving welding stresses in the welded article after the step of welding the wrought article to the cast article.

12. (Original) The process as in claim 11, wherein the first preselected period is about one hour, the second preselected period is about eight hours, and the third preselected period is about eight hours.

13. (Currently Amended) The process as in claim 12, wherein the process includes welding the treated cast article comprising a nickel-based superalloy having a nominal composition, in weight percent, of about 18.5 percent iron, about 18.5 percent chromium, about 5.1 percent niobium, about 3 percent molybdenum, about 0.9 percent titanium, about 0.5 percent aluminum, about 0.04 percent carbon, and balance nickel ~~of about 19 percent iron, about 18 percent chromium, about 5 percent terbium and niobium, about 3 percent molybdenum, about 0.9 percent titanium, about 0.5 percent aluminum, about 0.05 percent carbon, about 0.009 percent boron, a maximum of about 1 weight percent cobalt, a maximum of about 0.35 weight percent manganese, a maximum of about 0.35 weight percent silicon, a maximum of about 0.1 weight percent copper, balance nickel and impurities~~ to a wrought article comprising an iron-based superalloy having a nominal composition, in weight percent, of about 38 percent nickel, about 13 percent cobalt, about 4.7 percent niobium, about 1.5 percent titanium, about 0.15 percent silicon, about 0.03 percent aluminum, and about 42 percent iron ~~balance iron and impurities~~ after the cooling step, to yield a repaired article.

14. (Original) The process as in claim 13, wherein the process includes heat treating at a temperature in the range of about 1500°F to about 1600°F and holding for a first preselected period, followed by lowering the temperature to a temperature in the range of about 1400°F to about 1525°F and holding for a second preselected period, followed by lowering the temperature to a temperature in the range of about 1100°F to about 1200°F and holding for a third preselected period, so as to develop  $\gamma'$  and  $\gamma''$ , while also relieving welding stresses in the welded article after the step of welding the wrought article to the cast article.

15. (Original) The process as in claim 14, wherein the first preselected period is about one hour, the second preselected period is about sixteen hours, and the third preselected period is about eight hours.

16. (Currently Amended) The process as in claim 1, wherein the process includes welding the treated cast article comprising a nickel-based superalloy having a nominal composition, in weight percent, of about 19 percent iron, about 18 percent chromium, about 5 percent terbium and niobium, about 3 percent molybdenum, about 0.9 percent titanium, about 0.5 percent aluminum, about 0.05 percent carbon, about 0.009 percent boron, a maximum of about 1 weight percent cobalt, a maximum of about 0.35 weight percent manganese, a maximum of about 0.35 weight percent silicon, a maximum of about 0.1 weight percent copper, balance nickel and impurities to a wrought article comprising an iron-based superalloy having a nominal composition, in weight percent, of about 38.0 percent nickel, about 13.0 percent cobalt, about 4.7 percent niobium, about 1.5 percent titanium, about 0.4 percent silicon, about 0.01 percent carbon, about 0.001 percent boron, and about 42.0 percent iron ~~of about 38 percent nickel, about 13 percent cobalt, about 4.7 percent niobium, about 1.5 percent titanium, about 0.4 percent silicon, about 0.03 percent aluminum, about 0.01 percent carbon, balance iron and impurities~~ after the cooling step, to yield a repaired article.

17. (Original) The process as in claim 16, wherein the process includes heat treating at a temperature in the range of about 1500°F to about 1600°F and holding for a first preselected period, followed by lowering the temperature to a temperature in the range of about 1350°F to about 1450°F and holding for a second preselected period, followed by lowering the temperature to a temperature in the range of about 1100°F to about 1200°F and holding for a third preselected period, so as to develop  $\gamma'$  and  $\gamma''$ , while also relieving welding stresses in the welded article after the step of welding the wrought article to the cast article.

18. (Original) The process as in claim 17, wherein the first preselected period is about one hour, the second preselected period is about eight hours, and the third preselected period is about four hours.

19. (Cancelled)

20. (Cancelled)

21. (Previously Presented) The process as in claim 10, wherein the process includes heat treating at a temperature in the range of about  $1550^{\circ}\text{F} \pm 25^{\circ}\text{F}$  and holding for about one hour, followed by a heat treatment in the range of about  $1325^{\circ}\text{F} \pm 25^{\circ}\text{F}$  for about eight hours, followed by a heat treatment in a temperature in the range of about  $1200^{\circ}\text{F} \pm 25^{\circ}\text{F}$  for about one hour, so as to develop  $\gamma'$  and  $\gamma''$ , while also relieving welding stresses in the welded article after the step of welding the wrought article to the cast article.